**[1]Purva Padmawar, [2] Talat Sayyed, [3] Ashutosh Shinde, [4] Shubham Shinde, [5] Prof. Kavita Moholkar**

**[1] Department of Computer Engineering, [2] Department of Computer Engineering, [3] Department of Computer Engineering, [4] Department of Computer Engineering, [5] Department of Computer Engineering**

**[1]purvapadmawar@gmail.com, [2] talat.sayyed@gmail.com, [3] as.shinde343@gmail.com, [4] shubhamkshinde7@gmail.com, [5] kavita.moholkar@gmail.com**

***Abstract*–Flood is a natural crisis that can cause huge amount of loss to people. Generally, it occurs in the areas with high rainfall and causes high amount of water to enter into the residential places, which is life threatening. To overcome this issue early prediction systems are designed using different techniques to provide message to the people before the flood occurs in the area. The importance of predicting the flood is increasing widely. As floods can damage the human life, if it is predicted earlier it can prevent the loss to human and economy. Although the convolutional neural network (CNN) can be applied as the prediction model, the accuracy of the prediction results depends on the parameter values (e.g. precision, recall, Fscore). This paper proposes to apply the modified particle swarm optimization technique to tune up the parameter values in the CNN. In this system it includes two components, Modified Particle Swarm Optimizer (MPSO) and Convolutional Neural Network (CNN). MPSO is adapted to evolve the internal parameters of processing layers while Convolutional Neural Network will predict the flood.**

***Index Term - Convolutional Neural Network; Hybridized Particle Swarm Optimizer; prediction; disaster; flood; deep learning;***

## I. INTRODUCTION

A disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. Though often caused by nature, disasters can have human origins as well. There can be various types of disaster occur which are categorized as geological disasters, hydrological disasters, meteorological disasters, and wildfires. Among which floods, earthquakes, landslides occur thoroughly. As there are various areas which are flood prone causing tremendous loss to the society.

Flood is a common natural disaster that affecting a numbers of countries around the world. Despite it is common, yet flood can still be truly disastrous up to a point where it begins to cause massive destruction to public facilities, residential house or even worst, death [1].This affect tremendously toward to the economics structure of the country that must face this tragedy specially for the poor and developing one [1].

Flood prediction is a complex process of the numerous factors that influence water level such as rainfall, flow rate of the water, depth and height. There is no relation between the factors. Due to which it's quite tedious task to predict the flood. If the flood is predicted at earlier stage the loss to the society can be prevented or reduced. Predicting the flood can minimize the risk to human and economical losses.

Deep Learning is a part of machine learning methods. Machine learning is a technique in computer science which allows data to drive and guide the execution of algorithm [10]. Using a training dataset, the algorithm develops a model which is used to compare against the expected output [10]. An algorithm that uses deep learning goes through much the same process. Each hierarchy applies a transformation on the training input and forms it as a model [10]. This process is repeated until output has reached and an acceptable level of accuracy [10]. Learning can be supervised, unsupervised and semi-supervised. Deep Learning includes many networks such as CNN (Convolutional Neural Network), RNN (Recurrent Neural Network), Recursive Neural Network. These networks are basically algorithms

Numerous publications on flood prediction using Artificial Neural Network (ANN) techniques have been reported [4]. It has been suggested, because it has the powerful capability to model nonlinear and complex systems without clear physical explanation [3]. Now a day's one of the most famous practices in deep learning, CNN is making detection getting a better result in a disaster such as a flood, earthquake, and landslide [6]. The system is designed to predict the flood on the basis of current image of a particular flood prone area, on the basis of the image the system will predict whether the area is in danger and need to be relocate or not. The accuracy of the developed model is high due the use of Convolutional Neural Network and Modified Particle swarm optimization. The early prediction leads to save lot of lives and prevent more damage due to flood. The modified particle swarm optimization (MPSO) technique is applied as a parameter searching process for the CNN which shows good performance than the standard PSO algorithm [12].

## II. RELATED WORK

### A. *Literature Survey*

In [1] the author proposed a water level prediction system used to analyze the water level based on the flow rate and rainfall. The data obtained is from 2009 until 2013. Collectively there are 43819 numbers of data ranging from 1/1/2009 at 1:00:00 to 31/12/2013 at 24:00:00 with 1-hour interval. The system focuses on 5 different inputs and 1 output. The result is based on the 5 year measurement of the Kelantan River. The best neural network is selected according to the performance of the neural network based on the lowest means square error (MSE) obtained. From the study, the lowest MSE is obtained is 1.342 X 10-4 by using NNARX.

In [2] the author proposed WPopt model to predict the water level. In the proposed model the upstream water level has been applied to predict the downstream water level. The model consists of components, which are 1) *PSO* is applied as optimizer to seek for the optimal parameter for *ANN* training, and 2) ANN is applied to find the Predicted downstream level by using the upstream level data. The water level data has been observed by using the telemetry stations since July 2016. From the result the mean absolute percentage error (MAPE) is applied to measure the prediction accuracy of the model. In the training process, the MAPE value is only 1.88% and in testing process the MAPE value is only 7. 82%. In ANN training process the PSO algorithm found optimal parameters for the WPopt model.

In [6] the author proposed automatic natural disaster detection system for landslide and flood prediction by using convolutional neural network (CNN) to extract the feature of disaster more effectively. The dataset used in this paper is collection of two types of aerial imagery which are pre-disaster and post-disaster aerial imagery of both landside and flood taken from Google earth as input images. From the result we came to know that the research focuses on the changes occurred in the pre-disaster and post-disaster images, this also reduces error than the learning phase. If there is a change then it means that the disaster occurred. The accuracy is calculated based on three parameters such as precision, recall and fscore. In the result, the fscore for flood and landslide detection is in between 80-90%.

In [8] the author used seven layer CNN along with PSO for handwriting digit classification.CNN has ability to train the propose model by different method but PSO is the very used one in training of CNN. PSO algorithm trains the output layer weights of ConvNet in order to optimize the accuracy of image recognition. The data set used in this paper is the MNIST (Modified National Institute of Standards and Technology) data which it divided over two parts. First one contains 60,000 images used for training process and second one contains 10,000 images for test process. From the result, the accuracy performance reached is 97.67% in 4 epochs which it means that the proposed model is an efficient model for handwriting digit classification. The model also combines two optimization techniques to improve the accuracy performance of the CNN architecture, as PSO algorithm for the last layer and the SGD algorithm for the first six layers.

In [9] a novel Extended Kalman Filter (EKF) optimization algorithm was employed to overcome the nonlinearity problem and come out with an optimal ANN for the prediction of flood water level 3 hours in advance. The inputs used in the algorithm were current values of rainfall at the flood location and three upstream locations of river water levels. The real-time data is available online from website www.water.gov.my. From the result to overcome the problem of nonlinearity the extended Kalman filter (EKF) is added at the output of BPN. Back propagation neural network (BPN) is one of the most famous applications types of ANN. The prediction accuracy of the BPN model with EKF could be further improved by incorporating other parameters that will contribute to flood such as discharge, sediment and evaporation.

*B. Convolutional Neural Network*

CNN is a sequence of layers, and each layer of CNN transforms one volume of activations to another through differentiable function [6]. CNN consists of 3 primary hidden layers: convolution layer, pooling layer, as well as a fully- connected layer; which its neuron is arranged in 3 dimensions (width, height, depth).

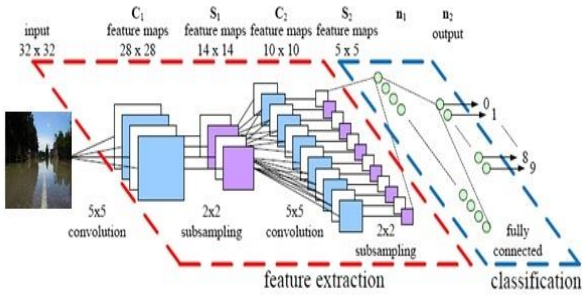


Fig.1. Basic Convolutional Neural Network Architecture

A Convolution Layer (CL) consists of filters and convolves them on an input image to extract features. CL (refer Fig.1) is the set of neighboring nodes in the lower layer connecting with nodes of upper layer and edges. CL is commonly used in image processing with a neural network. In other words, convolution layer performs feature extraction from images.

A Pooling Layer provides sub sampling to the output of the lower layer to achieve translational invariance. PL has a local connection with the lower layer, which is similar to CL. However, the method of calculating the value of the node is different from the fully-connected layer and convolution layer. The value determined from the local node in the lower layer is bringing forward to be upper layer's value.

In fully connected layer, each neuron in this layer is connected to all the numbers in the lower volume. Fully Connected Layer will compute the class scores and produce an outcome of [1x1x10], where each of the ten numbers resembles class score.

*C. Modified Particle Swarm Optimization*

Particle Swarm Optimization algorithm is a computational method for optimizing the problem by improve the target solution iteratively [8]. It optimizes the problem by using particles as a candidate solution so these particles fly over a search space according to mathematical equations to change the position and velocity of each particles, this changing of positions is influenced by its personal best position and guided toward global best which is best position in all search space found and agreed by other particles [8].

Modified Particle Swarm Optimization is the variation of a PSO algorithm which was proposed by Eberhart and Sin in 1997 and 1998. In MPSO algorithm, the birds have the memory to store the best and the worst position which helps each particle to recollect its previous worst position. The algorithm of MPSO is as follow:

Step 1. Set current iteration generation Iter=1. Initialize a population including m particles; Set the current position as the pbest position, the gbest is the best particle position of initialization particle swarm.

Step 2. Evaluate the fitness for each particle;

Step 3.Compare the evaluated fitness value of each particle with its pbest. If current value is better than pbest, then set the current position as the pbest position. Furthermore, if current value is better than gbest, then reset gbest to the current index in particle array;

Step 4.Change the velocity and position of the particle according to the equations (1) and (2), respectively;

Step 5. if (Iter%Ie==0) { Calculate d(t) of aggregation degree; if d(t) is less then given threshold value e, reinitialize velocities and position of particle; }

Step 6.Iter = Iter +1, If a stop criterion is met, end algorithm; else execute mutation operation to the gbest turn to step 2.

$$V_{p+1=} V_p + c_{1g} r_1 (p_{best} - x_p) + c_{1b} r_2 (x_p - p_{worst}) + c_2 r_3 (g_{best} - x_p) \quad (1)$$

$$X_{p+1} = X_p + V_{p+1} \quad (2)$$

Where $c_{1g}$ is acceleration coefficient which accelerates the particle towards its best position, $c_{1b}$ is acceleration coefficient which accelerates the particle away from its worst position, $p_{worst}$ is acceleration coefficient which accelerate the particle away from its worst position of the particle i, and r1,r2,r3 are uniformly distributed random numbers in the range [0 to 1].

## III. PROPOSED SYSTEM

The Fig.2 shows the proposed system for disaster prediction using deep neural network.

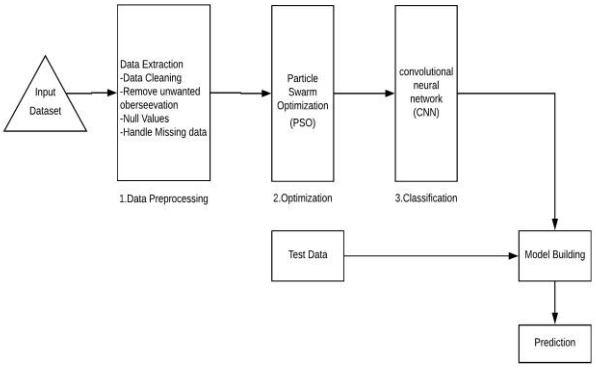


Fig.2. Proposed System

In this section we are describing our proposed model. We obtain images from the Google as input images for our model. The model works in three phases such as data preprocessing, optimization process and CNN training. In first phase the extracted data is pre-processed by performing some operation such as cleaning, removing unwanted observations, removing null values and handling missing values.

In the next phase the modified particle swarm optimization algorithm is applied to the output of the first phase which optimizes the data so the time taken by the CNN is reduced. The optimization algorithm provides the optimized particle so that the CNN can be trained more efficiently.

In the last phase the CNN is applied on the optimized data and the output is taken and prediction is performed on the output. The CNN has different architectures like ConvNet, LuNet, GoogleNet, AlexNet and more. We are using AlexNet in our model to reduce error rate.

## IV. CONCLUSION AND FUTURE WORK

The proposed flood model using deep learning structure is capable to predict the flood. In this system, the flood is predicted using the CNN and apply PSO to search for the parameter values. Based on the obtained result, it is known that the method that we proposed can automatically extract a relatively high accuracy to predict the flood. We believed that the research method proposed in this report has a potential to be implemented as the disaster prediction mechanism in every each of disaster relief center around the world. We also learn that the types of image pattern and number of training patches will affect the accuracy of results. Various pattern and a massive number of training patches will give a more promising result compared to a limited pattern and a few training patches.

The flood prediction model is capable of predicting the flood. In addition to the current system the preventive and curative measures will be given in case the flood is detected. As the system currently working on the images provided, further by using the sensors and camera the real time pictures will be used and prediction will be done on the basis of the camera/sensor images. Which will further used to provide the real time accurate predictions of flood prone areas. The system will be capable of intimating and providing the necessary actions to be taken to prevent or minimizing the human and economical losses.

## REFERENCES

[1] M. Anuar, R. Rahman, Z. Zulkafi "Early Prediction System Using Neural Network in Kelantan River, Malaysia," IEEE Student Conf.(2017).

[2] P. Panyadee, P.Champrasert, C. Aryupong "Water Level Prediction using Artificial Neural Network with Particle Swarm Optimization Model," IEEE International Conf. ICoICT(2017).

[3] F.Liu, F. Xu, S.Yang "A Flood Forecasting Model based on Deep Learning Algorithm via Integrating Stacked Autoencoders with BP Neural Network," IEEE Conf. on Multimedia Big Data(2017).

[4] K F.Ruslan, A.Samad, M.Tajjudin, R.Adnan "Flood Water Level Prediction Modeling Using NNARX Structure for Sg Pahang Basin",IEEE Internatinal Conf. 27 - 29 November 2015, Penang, Malaysia.

[5] F. Ruslan, A.Samad, R.Adnan "Modelling of Flood Prediction System Using Hybrid NNARXand Extended Kalman Filter" IEEE International (CSPA) 10 - 12 March 2017, Penang, Malaysia.

[6] S. Amit, Y.Aoki, "Disaster Detection from Aerial Imagery with Convolutional Neural Network." IEEE (IES-KCIC-2017).

[7] Wikipedia.org.

[8] M. Khalifa, M. Ammar, W. Ouarda, A. Alimi, "Particle Swarm Optimization for Deep learning of Convolution Neural Network " IEEE SCCSIT (2017).

[9] R.Adnan, F.Ruslan, A.Samad, Z.Zain, "Artificial Neural Network Modelling and Flood Water Level Prediction using Extended Kalman Filter." IEEE ICCSCE (2012).

[10] B. Wang, Y.Sun, B.Xue, M.Zhang " Evolving Deep Convolutional Neural Networks by Variable-length Particle Swarm Optimization for Image Classification",IEEE CEC (2018).

[11] https://searchenterpriseai.techtarget.com/definition/deeplearning-deep-neural-network.

[12] Y.Guangyou "A Modified Particle Swarm Optimizer Algorithm" IEEE International Conference on Electronic Measurment and Instruments.